Final Draft, July 7, 2000 , updated September 18, 2000
For Submittal to TAEIG

ARAC WG Report Format
For §25.1193(e) Cowl Skin Fire Protection

1 - What is underlying safety issue addressed by the FAR/JAR? [Explain the underlying safety rationale for the requirement. Why does the requirement exist?]

Prevention of hazards caused by a fire within an engine or APU fire zone burning through the fire zone external skin or exiting through a skin opening.

2 - What are the current FAR and JAR standards? [Reproduce the FAR and JAR rules text as indicated below.]

Current FAR text:

§ 25.1193 Cowling and Nacelle Skin.

(e) Each airplane must-

(1) Be designed and constructed so that no fire originating in any fire zone can enter, either through openings or by burning through external skin, any other zone or region where it would create additional hazards;

(2) Meet paragraph (e)(1) of this section with the landing gear retracted (if applicable); and

(3) Have fireproof skin in areas subject to flame if a fire starts in the engine power or accessory sections.

Note: Also applies to equivalent APU regulations contained in proposed appendix K to FAR 25, Para K1193(e).

Current JAR text:

Same, except for spelling of "aeroplane" versus "airplane."

Note: Also applies to equivalent APU regulations contained in JAR 25, Subpart J, Para 25A1193(e).

3 - What are the differences in the standards and what do these differences result in?: [Explain the differences in the standards, and what these differences result in relative to (as applicable) design features/capability, safety margins, cost, stringency, etc.]

There are no differences in the standards.

4 - What, if any, are the differences in the means of compliance? [Provide a brief explanation of any differences in the compliance criteria or methodology, including any differences in either criteria, methodology, or application that result in a difference in stringency between the standards.]

FAA policy requires, for pod mounted engines, that 180 degrees of nacelle skin centered on the strut or pylon, be fireproof unless specific substantiation of fire/fluid path from a burn-through shows that a lesser coverage (minimum of 90 degrees) will not create a hazard. The policy clearly refers to flight conditions but not to ground conditions, however, these are intended to be included.

JAA policy, as stated and applied per NPA 266, requires that:

- The entire nacelle skin be fireproof in flight, with consideration for external airflow.
- Those portions of the nacelle from which a burn-through could affect critical airplane systems or structure, expressed as pylon side area for pod mounted engines, be fireproof during ground operations.
- Other areas of the nacelle where a burn-through could hazard passenger evacuation be demonstrated to be fire resistant during ground operation.
- Remaining portions of the nacelle do not have a specific requirement.

5 – What is the proposed action? [Is the proposed action to harmonize on one of the two standards, a mixture of the two standards, propose a new standard, or to take some other action? Explain what action is being proposed (not the regulatory text, but the underlying rationale) and why that direction was chosen.]

FAR/JAR 25.1193(e) will be revised to clarify apparent inconsistency between 25.1193(e)(1) objective requirements and 25.1193(e)(3) prescriptive requirements, to avoid inconsistency between rule language and policy or advisory material, and to address acceptable differences in requirements for flight and ground operation.

Draft advisory material will be provided addressing acceptable means of compliance, and enveloping FAA and JAA policy for ground conditions.

6 - What should the harmonized standard be? [Insert the proposed text of the harmonized standard here]

§ 25.1193 Cowling and Nacelle Skin.

(e) Each airplane must-

(1) Be designed and constructed so that no fire originating in any fire zone can enter, either through openings or by burning through external skin, any other zone or region where it would create additional hazards; (Note: (e)(1) unchanged)

(2) Meet paragraph (e)(1) of this section with the landing gear retracted (if applicable); and (Note: (e)(2) unchanged)

(3) For in-flight operation from V1 to minimum touchdown speed, have fireproof skin in areas subject to flame if a fire starts in an engine fire zone, and for ground operation have fireproof skin in areas where a skin burn through would effect areas of the airplane critical for ground operation, and have skin which is either fire resistant or complies with (e)(1) in other areas.

7 - How does this proposed standard address the underlying safety issue (identified under #1)? [Explain how the proposed standard ensures that the underlying safety issue is taken care of.]

The proposed standard addresses the underlying safety issue by maintaining existing 25.1193(e)(3) prescriptive requirements for in-flight operations where a skin burn-through could have the greatest hazard potential, and by relying on existing 25.1193(e)(1) objective requirements, which are considered to contain the basic intent of the regulation, for ground operations where the hazard potential of a skin burn-through may be lower.

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [Explain how each element of the proposed change to the standards affects the level of safety relative to the current FAR. It is possible that some portions of the proposal may reduce the level of safety even though the proposal as a whole may increase the level of safety.]

The proposed standard provides an equivalent level of safety to the existing FAA and JAA interpretations of the regulations. The FAA has interpreted the current standard by a variety of Issue Papers, which have been summarized in the Draft Propulsion Mega-AC (under Section 25 1193 material). The JAA has interpreted the standard per NPA E-266, which has been applied as a Certification Review Item on numerous applications for many years. The proposed standard is a compilation of the most conservative aspects of existing FAA and JAA policies and industry practices. A review of service experience, involving several hundred ground and flight fires in Transport Category airplanes from 1982 through 1999 has demonstrated that these practices have provided an acceptable level of safety.

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [Since industry practice may be different than what is required by the FAR (e.g., general industry practice may be more restrictive), explain how each element of the proposed change to the standards affects the level of safety relative to current industry practice. Explain whether current industry practice is in compliance with the proposed standard.]

Relative to current industry practice, the proposed standard and advisory material maintains current level of safety.

Consideration has been given as to the safety effects in relationship to fire detection and extinguishing capability. It is concluded that the proposed standard and advisory material will retain at least the existing level of safety for the following reasons:

- The requirement for complete skin fireproofness in flight, which is most critical with respect to fire protection, will prevent impairment of these functions due to skin burn, through.
- Advisory material will specify fire resistance under ground conditions in those areas where a burn-through would adversely affect fire detection capability, thus maintaining consistency with FAR/JAR 25.1103(e) requirements.
- Advisory material will specify fire resistance under ground conditions in those areas where a burn-through would adversely affect fire extinguishing capability. This will not result in a decrease in safety due to the fact that fire extinguishing is not relied on to the exclusion of other protection means such as flammable fluid shutoff means, firewall integrity, and for ground operation, passenger evacuation. Additionally, a skin burn-through during ground operation is considerably less likely to affect fire extinguishing capability than it would be in flight, due to much lower external and internal air flow rates.

10 - What other options have been considered and why were they not selected?: [Explain what other options were considered, and why they were not selected (e.g., cost/benefit, unacceptable decrease in the level of safety, lack of consensus, etc.]

Option	**Reason for Not Selecting**
Delete 25.1193(e)(3) in favor of 25.1193(e)(1), which is a more objective and less prescriptive requirement.	Subjectivity could lead to inconsistent interpretations and resulting effects on safety.
Require strict compliance with existing 25.1193(e)(3), requiring fireproof skin without exception.	Not necessary for safety or consistent with long standing policy and practice with extensive service experience,
Provide advisory material enveloping existing policy and means of compliance, without a rule change.	Advisory material could be considered as improperly lessening the rule requirements.
Complete enveloping of the rules and policy	The existing FAA and JAA regulations have been interpreted by Issue Papers (FAA) and Certification Review Items(JAA) for many years. The task group considered it to be more beneficial to recommend the proposed changes to the rule in order to clearly reflect the existing FAA and JAA interpretations.
Delete required consideration of passenger evacuation per JAA policy, based on alternate evacuation route availability, lesser criticality compared to other evacuation scenarios, etc.	Unlikely to obtain harmonization due to differences, Task Group does not have necessary expertise or authority to address cabin safety issues.
Provide more specific criteria as to hazards to evacuation, such as acceptable proximity to evacuation routes, number of routes affected, etc.	Task Group does not have necessary expertise or authority to address cabin safety issues.
Provide more specific criteria for engines/APUs which are not pod mounted.	The variety of configurations and possible burn-through hazard potential does not lend itself to specific criteria. Case by case evaluation is more appropriate.
Provide Advisory Material addressing 25.1193(e)(2) requirement specifying applicability with landing gear retracted.	Neither TOR nor Task Group discussion disclosed a need for Advisory Material.

11 - Who would be affected by the proposed change? [Identify the parties that would be materially affected by the rule change – airplane manufacturers, airplane operators, etc.]

Aircraft manufacturers and other manufacturers involved in the design, testing, and certification of nacelles or other fire zone enclosures.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble? [Does the existing advisory material include substantive requirements that should be contained in the regulation? This may occur because the regulation itself is vague, or if the advisory material is interpreted as providing the only acceptable means of compliance.]

Current advisory material and policy includes JAA NPA-266, and FAA policy letters contained in the Draft FAR 25 Propulsion Mega-AC. Also, reference AC 20-135. A new Draft AC/ACJ has also been prepared. The following important elements of the draft AC/ACJ are appropriate for discussion in the preamble:

- Applicability to fire zone fires defined in AC 20-135 (or ISO 2865) (or proposed harmonized FAR 1/JAR 1) but not to engine case burn-through events covered separately under FAR/JAR 25.903(d)(1).
- Requirement for skin fireproofness in flight (from V1 to touchdown) with consideration for external airflow).
- Requirement for skin fireproofness on ground in critical areas where burn-through could result in explosion, significant spread of fire, or fuselage penetration. Critical areas for pod mounted engines defined to typically include from 90 to 180° of coverage, depending on specific installation.
- Requirement for fire resistant cowling on ground in less critical areas where burn-through could impair personnel evacuation, fire detection, or fire extinguishing.
- Requirement for skin fire withstanding capability equivalent to .040" (1.0 mm) aluminum in remaining areas not requiring fireproof or fire resistant skin.

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted? [Indicate whether the existing advisory material (if any) is adequate. If the current advisory material is not adequate, indicate whether the existing material should be revised, or new material provided. Also, either insert the text of the proposed advisory material here, or summarize the information it will contain, and indicate what form it will be in (e.g., Advisory Circular, policy, Order, etc.)]

No published FAA advisory material exists. Existing policy and draft advisory material is not adequate due to lack of harmonization with JAA policy and lack of clear differentiation between ground and flight requirements. Proposed new advisory material is attached.

14 - How does the proposed standard compare to the current ICAO standard? [Indicate whether the proposed standard complies with or does not comply with the applicable ICAO standards (if any)]

Unknown.

15 - Does the proposed standard affect other HWGs? [Indicate whether the proposed standard should be reviewed by other harmonization working groups and why.]

Cabin safety working group awareness of egress considerations may be advisable.

16 - What is the cost impact of complying with the proposed standard? [Is the overall cost impact likely to be significant, and will the costs be higher or lower? Include any cost savings that would result from complying with one harmonized rule instead of the two existing standards. Explain what items affect the cost of complying with the proposed standard relative to the cost of complying with the current standard.]

Relative to compliance with the existing rule, this change would reduce the cost, however relative to current practice, no significant cost change is expected for many applications. Some applicants may incur a minor cost increase due to either increased substantiation efforts, or application of existing skin fire protection methods over a larger nacelle area.

17 - Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

Yes.

18 – In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process. Explain. [A negative answer to this question will prompt the FAA to pull the project out of the Fast Track process and forward the issues to the FAA's Rulemaking Management Council for consideration as a "significant" project.]

The HWG considers that the "Fast Track" process is appropriate.

Attached is further technical discussion and proposed advisory material in the form of a draft AC/ACJ.

RESISTANCE TO FIRE OF NACELLE COWLINGS

PPIHWG Fire Protection Task Group -Final Draft
Feb 2, 2000

1. PARAGRAPH AFFECTED

FAR/JAR 25.1193 (e)

2. PROPOSAL

Add an AC/ACJ with following wording:

AC/ACJ 25.1193 (e)
Resistance to fire of Nacelle Cowlings (Acceptable Means of Compliance)
See FAR/JAR 25.1193 (e)

One, but not the only, acceptable means of showing compliance with Jar 25.1193(e) is as follows:

I. Regulatory History

To be added by FAA

II. Background

- Requirement originally developed for piston engine aircraft.
- Applicability to turbine engine aircraft has developed over the years to provide equivalent level of safety. The most recent FAA and JAA policy is:

  FAA policy requires, for pod mounted engines, that 180 degrees of nacelle skin centered the strut of pylon, be fireproof unless specific substantiation of fire/fluid path from a burn-through shows that a lesser coverage (minimum of 90 degrees) will not create a hazard. The policy clearly refers to flight conditions but not to ground conditions, however, these are intended to be included.

  JAA policy, as stated and applied per NPA 266, requires that:
  - The entire nacelle skin be fireproof in flight, with consideration for external airflow.
  - Those portions of the nacelle from which a burn-through could affect critical airplane systems or structure, expressed as pylon side area for pod mounted engines, be fireproof during ground operations.
  - Other areas of the nacelle where a burn-through could hazard passenger evacuation be demonstrated to be fire resistant during ground operation.
  - Remaining portions of the nacelle do not have a specific requirement.

III. Applicability

This advisory material addresses the engine nacelle fire zone skin and APU compartment fire zone skin requirements of FAR/JAR 25.1193 (e), which reads as follows:

> (e) Each airplane must--
>
> (1) Be designed and constructed so that no fire originating in any fire zone can enter, either through openings or by burning through external skin, any other zone or region where it would create additional hazards;
>
> (2) Meet sub-paragraph (e)(1) of this paragraph with the landing gear retracted (if applicable); and
>
> (3) For in-flight operation from V1 to minimum touchdown speed, have fireproof skin in areas subject to flame if a fire starts in an engine fire zone, and for ground operation have fireproof skin in areas where a skin burn through would effect areas of the airplane critical for ground operation, and have skin which is either fire resistant or complies with (e)(1) in other areas.

This advisory material also addresses the equivalent APU fire zone external skin requirements contained in FAR 25, Appendix K, Para. K1193(e), and JAR 25, Subpart J, Para. 25A1193(e).

II. Fire Barrier Requirements, Operating Conditions, and Potential Hazards.

A. General

The required level of ability to withstand the effects of fire varies with the potential hazard level associated with different flight and ground operating conditions, as follows:

B. Flight Conditions

For flight conditions from airspeed above V1 until minimum touchdown speed in approved normal or abnormal operations, the skin in areas subject to flame if a fire starts in an engine or APU fire zone shall be demonstrated to be fireproof. The conditions for demonstrating the fireproof capabilities of the cowling should be consistent with the critical operating conditions. Where engine power can affect conditions on the cowling (including max engine power, min engine power and propeller feathering), these should be examined and the most critical determined. These conditions should be applied for 5 minutes, with the remaining 10 minutes under engine windmilling conditions.

C. Ground Conditions.

1. Engine Operation Requirements for ability of skin in areas subject to flame if a fire starts in an engine or APU fire zone to withstand the effects of fire under ground operating conditions apply with either the engine operating or not operating, whichever is the more critical.

2. Nacelle areas where fireproof skins are required - The portion of skin in areas subject to flame if a fire starts in an engine or APU fire zone, and located so that a skin burn-through could result in a serious injury to crew, passengers or ground personnel, should be fireproof under all conditions. Serious hazards include, but are not limited to, events such as fuel tank explosion, hazardous spread of fire to flammable fluid sources outside the fire zone, or fuselage penetration.

2.1. Pod mounted engines: The portion of the nacelle skin, which is required to be fireproof on ground, varies by installation. A design is considered acceptable when it is demonstrated that the fireproof area protects the pylon strut and other portions of the aircraft considered to be put at a serious hazard risk if burn through occurs. Factors to consider within the analysis and to use when substantiating the design are: the engine location - wing or aft mounted, the coupling distance of the nacelle to the wing, the airflow characteristics, the fluid migration scheme and the fire plume patterns. After the initial analysis, a similarity demonstration may be used when appropriate. Analyses have demonstrated that the typical area of concern ranges from 90° (±45°) to 180° (± 90°). This area may increase or decrease depending on the analysis results. For example, most wing mounted engines not closely coupled to the wing have been found acceptable with a ±45° protection while more closely coupled installations and those with other unique design features have required ±90°protection.
The symmetry of the protection may also vary. Wing mounted engines usually have symmetrical protection while aft mounted engines may have non-symmetrical protection in order to cover more of the inboard area.

2.2. Turboprops and APUs and other non-pod mounted engines: Due to the wide variations in installation configurations each installation should be evaluated to determine if a skin burn-through would cause a serious hazard such as the examples above. If so the affected area of the fire zone skin should be fireproof. Examples of common configurations, which have been found to be acceptable, are:

- Stinger mounted APUs not requiring fireproof skins if critical parts of the airplane are not exposed.
- Stinger mounted APUs requiring partial fireproof skins, such as ±45° to protect adjacent critical parts of the airplane.
- APUs mounted in fireboxes internal to the fuselage where the side of the box, which is external skin, is fireproof to protect against re-entering of a fire which burns through.

3. Other nacelle areas: - For the remaining portions of skin in areas subject to flame if a fire starts in an engine or APU fire zone, the degree of fire protection can be lower than "fireproof" due to less serious or less probable hazard of a burn-through to the airplane and / or its passengers under the critical operating conditions.

Fire resistant skins provide adequate fire protection for those areas in that they provide sufficient time to stop the airplane and evacuate it.

A lower than "fire resistant" degree of fire protection has been used by applicants in the past

without adverse service experience and can be considered under the following conditions:

- nacelle skin should have the ability to withstand fire at least equivalent to 0.040" (1 mm) aluminum
- applicants must substantiate that this lower fire protection level will not lead to hazardous effects such as :

  - Reduction in evacuation capability due to proximity to escape routes or due to the visibility of the fire hindering the ability of the passengers to evacuate the airplane in a rapid and orderly manner. Visibility effects are a combination of line of sight to the fire and proximity. For example, an over wing exit may require no line of sight, while line of sight may be permissible for a forward exit due to greater distance from the nacelle. (Note: There is some hazard involving passenger evacuation even in the absence of burn-through, due to such concerns as smoke and flaming liquids exiting from openings. Burn-through of nacelle skin should not significantly increase these hazards.)

  - Reduction in fire detection capability such that the flight crew would not be aware of the fire, especially in a situation involving taxiing prior to takeoff.

  - A reduction in fire extinguishing capability which could cause or aggravate one of the potential hazards listed above

III. Specific Configuration Considerations

A. Multiple Skin Layers

For some specific fire zones, a fire originating in that zone will have to pass through several layers of skin or cowling before burning through the nacelle external skin. This may be the case, for example, for the core zone of some turbofan installations. In such cases, credit may be taken for multiple layers, having regard to the location of the fire source and the likely direction of propagation from that location, providing burn-through of the inner layer does not produce other hazardous effects as well as does not invalidate other certification requirements such as fire extinguishing capability. The corresponding compliance substantiation should take into account particular geometrical configuration with respect to risk of flame propagation, as well as critical systems or structures.

B. Inlet Skins

External inlet skins, which enclose fire zones, should meet the same criteria discussed. Inlet ducts should meet the requirements of 25-1103.

C. Openings

The following considerations are applicable to openings in a fire zone skin, whether the openings are of fixed size, variable or controllable size, or normally closed, such as access or inspection doors, or pressure relief doors.

- Openings should be located such that flame exiting the opening would not enter any other region in where it could cause a hazard in flight or a serious hazard per II.C on the ground, except for covered openings which meet the same criteria for ability to withstand the effects of fire as the surrounding cowl skin, and which are not expected to become open under fire conditions. Since pressure relief doors may open during some fire conditions, they should be located so that flames exiting the door will not cause a hazard. However, since the doors will remain closed during most fire conditions, or will tend to re-close following initial opening, the doors can be assumed to be closed for the purposes of fire detection and extinguishing.

- Openings should have the same ability to withstand the effects of fire as the adjacent skin with respect to becoming enlarged under fire conditions. Some enlargement, such as burning away of louvers or doublers surrounding the opening or gapping of covered openings, is acceptable providing that the hazard is not significantly increased by a reduction in fire extinguishing or detection capability, increased airflow causing increase in fire size or intensity, or increase in probability of a hazardous spread of fire to other regions.

IV. Compliance demonstration

Compliance should be substantiated per FAR/JAR 25.1207. Substantiation involving airflow patterns may include analytical methods such as Computational Fluid Dynamics, test methods such as tufting or other flow visualization methods or a combination. Fire testing should be accomplished per the guidance of AC 20-135 (ISO 2685).